

CLAIMS

1. An apparatus for detecting the presence or absence of a target object at a site of a collet assembly, the apparatus including a source of light adapted for illuminating at least a portion of the site, and a light detector adapted for receiving at least a part of the light from the source when reflected by a target object located at the site.
2. An apparatus as claimed in claim 1, adapted for detecting the presence of the target object at the site when the target object presents a surface substantially at a predetermined orientation, wherein said illumination is incident upon said portion of the site substantially normal to said orientation.
3. An apparatus as claimed in claim 1, further including a beam splitter, wherein light from said source travels through the beam splitter to illuminate said portion of the site, and said light reflected by the target object is further reflected, by the beam splitter, toward the light detector.
4. An apparatus as claimed in claim 1, wherein a beam splitter reflects light from said source toward said portion of said site and said light reflected by the target object travels through the beam splitter to the light detector.
5. An apparatus as claimed in claim 1, wherein the light detector is an image sensor.
6. An apparatus as claimed in claim 1, wherein the light detector is a power sensor.
7. An apparatus as claimed in claim 1, wherein the light is visible radiation.
8. An apparatus as claimed in claim 1, wherein light from the source is collimated or focused into a beam for illuminating said portion of the site.

9. An apparatus as claimed in claim 8, wherein the illuminating beam is approximately 0.02 to 0.5 mm wide at said portion of the site.
- 5 10. An apparatus as claimed in claim 1, wherein the source of illuminating light and the light detector are both on one side of the site.
11. An apparatus as claimed in claim 10, including a dark background located on the opposite side of the site.
- 10 12. An apparatus as claimed in claim 1, wherein the target object is substantially transparent.
13. An apparatus as claimed in claim 12, wherein the target object has a refractive index not equal to 1.
- 15 14. An apparatus as claimed in claim 13, wherein the refractive index is approximately 1.55.
- 20 15. An apparatus as claimed in claim 1, wherein either or both of the source of light and the light detector are located remotely from the collet assembly.
16. An apparatus as claimed in claim 15, including a device to direct light between either or both of the source of light and the light detector and the collet assembly that is selected from the group consisting of optical fibers, mirrors and light guides.
- 25 17. A die handling device including a collet assembly for holding a die, and an apparatus as claimed in any one of the preceding claims, wherein the die is the target object.
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18. A method of determining the presence or absence of a target object at a site of a collet assembly, including the steps of:
- (a) illuminating at least a portion of the site,
 - (b) arranging a light detector to receive at least a part of the illuminating light when reflected by a target object located at the site, and
 - (c) detecting said illuminating light reflected by said target object and received by said detector.
19. A method as claimed in claim 18, the method determining the presence of the target object at the site when the target object presents a surface substantially at a predetermined orientation, wherein said illuminating light is incident upon said portion of the site substantially normal to said orientation.
20. A method as claimed in claim 18, further including the steps of:
- (d) passing said illuminating light through a beam splitter to illuminate said portion of the site, and
 - (e) further reflecting said light reflected by the target object, by the beam splitter, toward the light detector.
21. A method as claimed in claim 18, further including the steps of:
- (f) reflecting said illuminating light from a source toward said portion of said site, by a beam splitter, and
 - (g) passing said light reflected by the target object through the beam splitter to the light detector.
22. A method as claimed in claim 18, wherein the light detector is an image sensor.
23. A method as claimed in claim 18, wherein the light detector is a power sensor.
24. A method as claimed in claim 18, wherein the light is visible radiation.

25. A method as claimed in claim 18, including the further step of:
(h) collimating or focusing the illuminating light into a beam for illuminating said portion of the site.

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26. A method as claimed in claim 25, wherein the collimated or focused illuminating beam is approximately 0.02 to 0.5 mm wide at said portion of the site.

27. A method as claimed in claim 18, wherein the detection of said reflected illuminated light in step (c) is made with a dark background in the direction
10 opposite to that in which light is reflected by the target object located at the site.

28. A method as claimed in claim 18, wherein the target object is substantially transparent.

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29. A method as claimed in claim 18, wherein the target object has a refractive index that is not equal to 1.

30. A method as claimed in claim 29, wherein the refractive index is
20 approximately 1.55.

31. A method as claimed in claim 18, further including the steps of:
(i) making an attempt to pick up an object with the collet assembly,
(j) illuminating a predetermined site at the collet assembly,
25 (k) arranging a detector to detect illuminating light reflected from said site at the collet assembly,
(l) making a determination of the presence or absence of the object at the site at the collet assembly, the determination being based on the light detected by the detector.

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32. A method as claimed in claim 31, wherein the detection of light reflected from the site in step (I) is made with a dark background in the direction opposite to that in which light is reflected by the object when located at the site.
- 5 33. A method as claimed in claim 18, further including the step of storing a measured intensity value with a reasonable margin added to replace a stored reference intensity value which is used to determine whether an object is absent.